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Preface

The International Neem Network, co-ordinated by FAO, was established in 1993 with the long term objective to improve the genetic quality and adaptability of Neem and to improve its utilisation. The network collaborators have undertaken activities in provenance exploration, seed collection and exchange as well as establishment of internationally coordinated trials. In addition, the network has undertaken research in seed physiology and technology, genetic diversity and reproductive biology, as well as studies on variation in chemical compounds. National institutes in 21 countries are collaborating in the network together with a number of international organisations and projects. A total of 35 trials were established within 1995/1997. A number of international institutes have co-operated with FAO (Food and Agricultural Organisation) and DFSC (Danida Forest Seed Center), which later merged into Forest & Landscape (FLD), and in 2006 an agreement of co-operation was established between Royal Forest Department (RFD), Thailand concerning a follow-up on Neem in Thailand with participants from Thailand, Vietnam Myanmar and Laos.

Two provenance trials of neem were established in Thailand in 2007. RFD and FLD arranged a measurement of the existing trials and a work-shop on statistical analysis in 2007. This is a status report of one of the trials within the International Neem Network series. The project has been funded by DANIDA and supported by RFD and FLD.

Abstract

A nine-year-old *Azadirachta indica* provenance trial of comprising 24 provenances from 9 regions (countries) in the world was evaluated. The field trial was established in 1997 in Kanchanaburi province in a randomized complete block design with 4 blocks and 25 trees per plot. Survival rate, height (H), diameter at breast height (DBH), stem form and number of stems were recorded.

The results showed that the mean of all characters were significantly different at regional levels. Provenances within region also showed significant differences for most traits. Averages of survival, height, diameter at breast height (DBH), total basal area, number of stems and the score of stem form of the Neem plantation were 77.7%, 5.6 meters, 8.1 centimeter, 1,020 cm^2, 1.8 stem and 4.1, respectively. The provenances from Annur-India and Khao Luang-Thailand showed highest survival percentages (98% and 95%, respectively), whereas provenance Ban Nong Hoi-Thailand performed best for stem form (6.2). Provenance Ban Nong Rong-Thailand showed the highest total basal area (1,885 cm^2). Most of the seed sources showed moderate score in stem form. Provenance Tung Luang presented the lowest growth performance. The provenances which performed well for many characteristics should be considered for use in future improvement programmes.

Keywords: Provenance trials, *Azadirachta indica* A. Juss (NEEM), Growth performance.

Acronyms

AFTSC	ASEAN Forest Tree Seed Centre
DANIDA	Danish Development Assistance
DBH	Diameter at Breast Height
DFSC	Danida Forest Seed Centre
F/FRED	Forestry and Fuelwood Research and Development Project
FAO	Food and Agricultural Organisation
FLD	Forest & Landscape Denmark
RFD	Royal Forestry Department, Thailand
SRC	Silvicultural Research Centre

Contents

1. Introduction

The term »provenance« has been commonly used by tree breeders to explain a geographic source of seed or plant material. Thus a provenance trial is an experiment in which seeds are collected from a number of widely scattered promising stands, and the seedlings and trees are grown under similar conditions (Bhumibhamon, 1979). The provenance trials are carried out for very practical reasons; to screen nationally available populations for reforestation and possibly for further breeding work (Wright, 1976) or they are mostly aimed at screening superior provenances. Plus trees can be selected for seed orchard establishment from provenances that show superiority in the provenance trials. The criteria used in determining the good provenances are not always superior growth, but also high survival, resistance to biotic enemies, good wood quality, etc.

Evaluation of the best seed sources or provenances is time consuming but useful good quality sources may be found after one or two generations (Pinyopusarerk, 1980). After provenance trial evaluation, promising provenances could be used as a source for further tree improvement programmes, including the establishment of provenance seed production area, plus tree selection, *ex situ* gene conservation stand, or used as the seed sources for new plantation establishment (Rattanachol, 1997).

Neem (*Azadirachta indica A. Juss.*) belongs to the MELIACEAE or mahogany family. In Thailand, three varieties of Neem are identified, *Azadirachta indic*a A. Juss. (Indian neem), *A. indica* A Juss. var. *siamensis* Valeton (Thai neem), and *A. excelsa* (Jack) Jacobs (Philippine neem) (Boonsermsuk and Chittavhamnonk, 1989). *Azidiractha indica* var *siamensis* is native to Thailand. Moreover it has a wide natural distribution with the most dense population structure occurring on termite mounds and ridges in paddy fields or scattered in some of the dry Dipterocarp forests. With a few exceptions the variety does not occur in moist deciduous forests or at altitudes above 200 meters. Indian neem and Phiippine Neem was introduced to Thailand. Indian neem was planted on a small scale in Thailand and Philippine neem has been planted more in the south of Thailand (Bhumibhamon and Kamkong, 1997).

Neem in Thailand is known by the names »Sadao india« or »Quinine« is one of the most valuable evergreen multipurpose trees native to the Indian subcontinent and Southeast Asia. In Thailand it is a valuable native multipurpose tree species which grows well in various sites with poor soils and low annual rainfall. The natural distribution of neem is in dry evergreen forests in India subcontinent and Southeast Asia. In Thailand, the natural distribution of neem mainly is in the southern part of Northern region, Central plain, Western mountains and Eastern provinces. It is found growing in remnant forests, marginal land, molehills in rice field, roadside, etc. The species spread slowly and gradually from existing populations into clearings and other types of open land made by human intervention. Thus, most neem populations in Thailand may be considered as natural populations, some of which have spread slowly and relatively recently.

The species is highly efficient in restoring soil productivity and simultaneously providing fodder, fire wood, and other products to meet basic needs in the rural households like medicines, pesticides, mosquito repellants, fertilizers, diabetic food, soaps, lubricants, gums, agricultural implements, tooth paste, tooth brush sticks and contraceptives. Due to its high economic importance, rapid growth and wide range of natural distribution Royal Forest Department (RFD) has placed it on the list of high priority species within the tree improvement. The First International Consultation on Neem Improvement was held in Bangkok during 8 – 22 February 1993 with representatives from F/FRED (Forestry and Fuelwood Research and Development Project), FAO (Food and Agricultural Organisation), DFSC (Danida Forest Seed Center), RFD and other national research institutes to set up working group for neem improvement project. The meeting was agreed to carry out international Provenance trials with the cooperation from 17 countries in Asia, Africa and Latin America. The objective of the trials are to increase knowledge of growth and site requirement of different provenance, to provide a focus for network cooperation and expansion and to help improve and standardize forestry and agro forestry research methodology (Read and French, 1993).

The objective of the present study is to identify promising provenances on growth characteristics of neem evaluated nine years after planting. The results will provide the basic information in future tree improvement initiatives.

2. Material and Methods

2.1 Seed Collection

As a result of the survey of natural presence of neem in Thailand carried out by DFSC and RFD in 1992 39 provenances were visited and described (Lauridsen et al 1991). Out of these provenances, 4 sources - Nong Rong 1, Doi Tao, Ban Bo and Tung Luang were chosen to be included in International provenance field trials. Seed collection was carried out during 18 March 14 April 1995. Seeds from each provenance were collected from 30 – 42 trees in an area of at least 100 – 200 ha. Greenish – yellow seeds of ea. 2 kilograms from each tree were collected from the middle of crown. Seeds were kept separately in gunny bags, under shade 1 – 2 days before sending to ASEAN Forest Tree Seed Centre (AFTSC) for depulping. After fumigation, the seeds were then dispatched to participating countries within the International Neem Network.

2.2 Seedling preparation

Neem seeds from abroad were sent from RFD directly to Silviculture Research Centre 3 (SRC 3), Kanchanaburi province for seedling preparation. Some were sent to RFD seed section for germination test and the results obtained were reported (Boontawee, 1996). Seed from 24 sources (6 from Thailand, 8 from India, 2 from Myanmar, Nepal, Pakistan, 1 from Ghana, Laos, Senegal, Srilanka.) were germinated at Sil. Res. Centre 3. In May 1996, Seedlings from 22 provenances, excluding Tanzania and Bangladesh due to poor germination of seeds, were sent to Silviculture Research Centre 5 (SRC 5) for field trial in wet site at Kamphaeng Phet Province. Seedlings from 2 Thai. provenances from 1993 seed collection Densariem, Tak province and Sai Ngarm, Kamphaeng Phet, Province were included, making a total of 24 provenances in the field trial at Kamphaeng Phet province (Table 1).

2.3 Site Condition and experimental design

The study was carried out in the Kanchanaburi Province, Western Thailand. The planting site was rather flat and homogeneous. A Randomize Complete block design) was applied with 4 replications. Plot size is 5 x 5, 25 trees with a spacing of 3 x 3 meters (Figure 1). One buffer row of local neem was planted around each block. The block corner were demarcated by using concrete posts dug down in the ground. Intensive site preparation was carried out in March – April, 1997 and planting was conducted at the beginning of August 1997. Planting and post planting maintenance and design of trial followed procedures as recommended by the International Neem Network (Anon, 1996). The precipitation in the area is 1020 mm/year which is much less than at Kamphaeng Phet (1800 mm/year).

Table 1 Seed sources for the international provenance trial of neem established in the Kanchanaburi Province in 1997

No.	Seed Sources	Lat.	Long.	Alt.(m.)	Rainfall (mm.)	Code
	Ghana					
1.	Sunyani	07° 21° N	02° 21° W	950 - 1000	1270-1400	09/GHA/Sun
	Lao					
2.	Vientiane	18° 00° N	102° 45° E	180	1674	05/LAO/Vie
	Senegal					
3.	Bandia	14° 35° N	17° 02° W	15	690	24/SEN/Ban
	Sri Lanka					
4.	Kuliyapitiya	07° 03°N	80° 81° E	-	-	23/SRL/Kul
	Myanmar					
5.	Yezin	19° 51°N	96° 16° E	100	1269	08/MYA/Yez
6.	Myene	22° 03° N	95° 13° E	76	809	10/MYA/Mye
	Nepal					
7.	Lamahi	-	-	350 – 440	-	19/NEP/Lam
8.	Geta	28° 46° N	80° 34° E	170	1725	20/NEP/Get
	Pakistan					
9.	Tibbi	28° 24° N	70° 18° E	115	140.1	21/PAK/Tib
10.	Multan	31° 11° N	71° 29° E	< 150	276	22/PAK/Mul
	India					
11.	Rammanaguda	19° 05° N	83° 49° E	250	1340	07/INDRam
12	Sagar	21° 51° N	78° 45° E	527	1715	11/INDSag
13.	Balharshah	19° 51° N	79° 25° E	250	850–1200	12/IND/Gha
14.	Ghaati	13° 22° N	77° 34° E	950	741	13/IND/Sub
15.	Chitradurga	14° 02° N	76° 04° E	615	417.4	14/IND/Chi
16.	Mandore	26° 18° N	73° 01° E	224	373	15/IND/Man
17.	Annur	11° 17° N	77° 04° E	360	750–100	16/IND/Ann
18.	Allababad	25° 28° N	81° 54° E	320	910	17/IND/All
	Thailand					
19.	Ban Bo	16° 17° N	103° 35° E	150	1400	01/THA/Ban
20.	Ban Nong Rong	14° 05° N	99° 40° E	40	1145	03/THA/Non
21.	Doi Tao	17° 57° N	96° 41° E	300	1250	04/THA/Doi
22.	Tung Luang	09° 09° N	99° 07° E	4	1755	06/THA/Tun
23.	Ban Nong Hoi	14° 09° N	99° 19° E	100 – 200	1150	25/THA/Hoi
24.	Khao Luang	15° 32° N	99° 57° E	90	1175	26/THA/Kha

20	**14**	**6**	**11**	**16**	**19**	
24	**5**	**2**	**23**	**18**	**3**	**Rep.1**
4	**12**	**1**	**9**	**8**	**22**	
17	**21**	**7**	**13**	**10**	**15**	
18	**20**	**15**	**8**	**2**	**5**	
4	**14**	**1**	**12**	**16**	**23**	**Rep.2**
11	**21**	**7**	**3**	**10**	**13**	
24	**19**	**17**	**22**	**9**	**6**	
13	**11**	**1**	**9**	**21**	**10**	
8	**23**	**12**	**15**	**19**	**18**	**Rep.3**
2	**5**	**14**	**17**	**4**	**22**	
6	**7**	**16**	**24**	**3**	**20**	
2	**22**	**4**	**11**	**8**	**1**	
21	**17**	**19**	**18**	**3**	**13**	**Rep.4**
15	**23**	**14**	**5**	**16**	**10**	
20	**24**	**9**	**7**	**12**	**6**	

Planting design

Randommized Completely Block Design (RCBD)

No. of Provenance	:	24 Provenances
No. of Block (Rep.)	:	4 Blocks
No. of Tree plots	:	25 trees/plot
Spacing	:	3 x 3 meters
Planted in	:	September, 1997

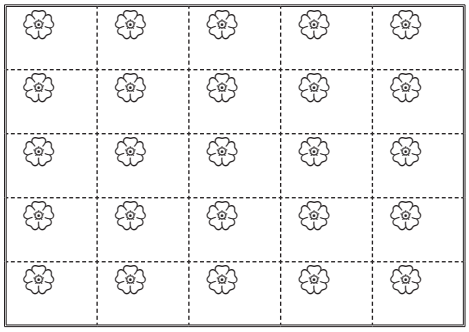

Figure 1. Planting design of international provenance trial of neem established at Kanchanaburi Province in 1997

2.4 Measurement of tree performance

Nine years after planting, measurements were carried out. The characters height, diameter at breast height (DBH), number of stems (originating from under 1.30 m) and stem form of the main stems were measured on all trees in the trials. Bases on these measurements, basal area of individual trees, total basal area of plots and survival were calculated.

Stem form, or straightness was assessed according to a slightly modified scale developed by Emmanuel et al. (1997). The total number of stems was counted at 1.3 m height. Stems were defined as all upright stems above 1 cm in diameter. The branches should be appearing from a point below 1.3 m (e.g. not counting branches hanging down from above).

The trees were grouped in three main classes based on main features: straight trees, wavy trees and crooked trees. Each main class is then divided in three subclasses. All trees in this study had wavy stems while trees with crooks were almost absent. The distinction between subclasses can be more or less uncertain by human judgment. Since the stem form is based on individual judgment, it is important that the same person assess the value within each block and preferably also within each trial.

Main classes	**Examples**	Definitions
Straight trees (value 7-9)		Straight stems have no severe bends, nor a wavy appearance. The distinction between the classes can be that some stems are slightly twisted or other less severe faults for timber.
Wavy trees (value 4-6)		Wavy stems do not have crooks (severe bends) see below. The distinction between subclasses can be more or less waving appearance'  A bend (waving)
Crooked trees (value 1-3)		A crook is a bend where a line from each end of the curve falls outside the stem - see drawing. The distinction between subclasses can be the number of crooks or other severe faults like twisting  A crook

Survival percentages (the ratio between number of living trees remaining and number of trees originally planted) for individual plots, blocks and provenances can be calculated using the health status assessments.

2.5 Statistical Analysis

The growth characteristics were analyzed by using the GenStat Discovery Edition Program. A general linear model was applied for data analysis of each trial, and all calculations were based on plot means. Least-square means and standard deviation estimates were produced for the overall analysis. The statistical univariate analysis proved that all quantitative data were normally distributed, and there were no significant deviations caused by missing data.

3. Results

3.1 Variation on growth performance

Growth performance is shown in Table 2

3.1.1 DBH

The diameter at breast height is an important character and generally used in determining the growth of a tree. The diameter was measured at the 1.30 m above ground level.

In the present study the mean diameter growth was 8.1 cm. The highest diameter was found for provenance Doi Tao, Thailand which was 10.2 cm, while the lowest was found for provenance Tung Luang, Thailand (6.0 cm) (Figure 2). The was a significant difference between provenances, but there was no significant differences between blocks (Table 3).

Compared to another study of neem provenances with Thai neem established at the Surat Thani Province, the results showed that the mean diameter of 4 year old neem from the Phaisali provenance had the largest diameter (6.7 cm), while the tree with smallest diameter (3.2 cm) came from Doi Tao (Hongthong, 2007) (Se annex 1).

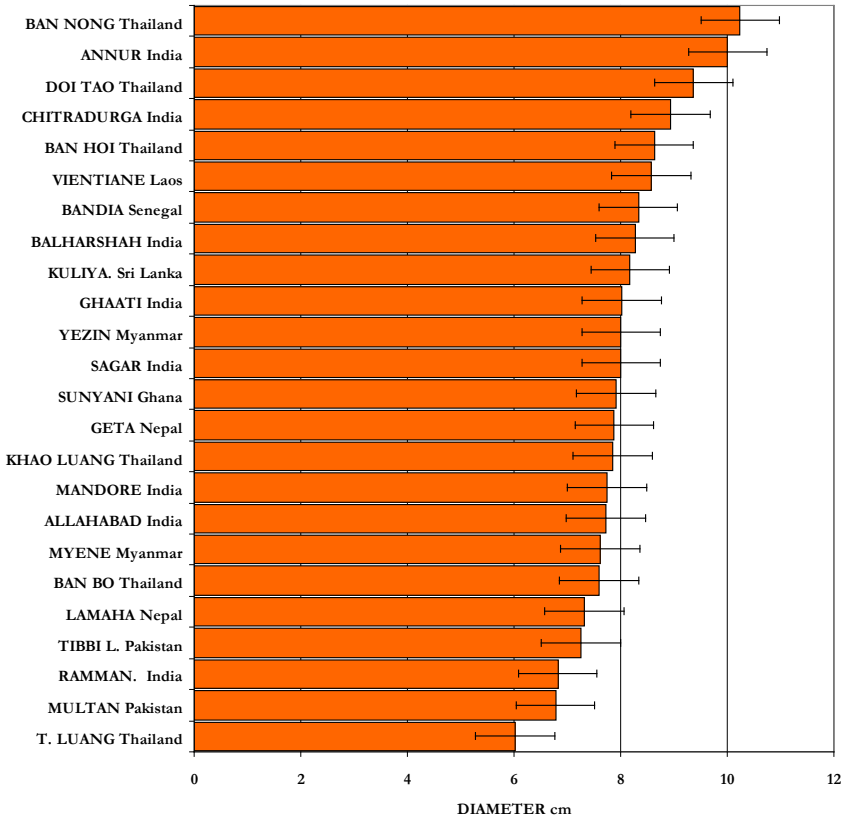

Figure 2. DBH for the nine-year-old *Azadirachta indica* at the Kanchanaburi Province

Table 2 Means and standard deviations on 9-year *Azadirachta indica* characteristics in the International Provenance Trial at Kanchanaburi Province

No	Provenance		DBH (cm)		Height (m)		Basal Area (cm2)		Total Basal Area (cm2)		No of stem (tree)		Survival (%)		Stem form	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	Ban Bo	Thailand	7.7	0.83	4.9	0.50	46	10	875	194	1.2	0.15	75	16.1	4.9	0.3
2	Ban Nong Hoi	Thailand	8.0	1.77	6.2	0.85	52	23	1201	474	1.1	0.07	93	6.8	6.2	1.6
3	Ban Nong Rong	Thailand	10.0	2.04	7.1	1.25	81	32	1885	695	1.1	0.04	94	7.7	5.6	0.5
4	Doi Tao	Thailand	10.2	1.09	6.5	0.73	83	17	1640	249	1.1	0.11	80	7.3	5.4	0.7
5	Vientiane	Laos	7.6	0.74	4.9	0.46	46	8	846	369	1.0	0.05	76	32.2	4.7	0.4
6	Tung Luang	Thailand	6.0	1.05	4.5	0.84	29	9	493	128	1.0	0.00	71	18.0	4.9	0.6
7	Rammanaguda	India	8.3	1.11	5.9	0.74	54	14	1107	245	1.7	0.23	82	5.2	4.3	0.4
8	Yezin	Myanmar	8.3	1.72	5.7	1.15	56	22	1280	571	2.4	0.17	90	10.6	3.5	0.2
9	Sunyani	Ghana	6.8	0.90	5.5	0.55	37	10	705	262	2.2	0.19	76	14.2	3.5	0.1
10	Myene	Myanmar	6.8	0.71	5.0	0.44	36	8	820	131	2.2	0.32	91	8.3	3.5	0.2
11	Sagar	India	8.2	1.92	6.0	1.28	55	27	1012	892	1.5	0.52	65	30.8	4.0	0.5
12	Balharshah	India	7.9	0.35	5.7	0.34	49	4	1024	135	2.5	0.45	83	6.0	3.6	0.3
13	Ghaati	India	9.4	0.63	5.8	0.50	69	10	1556	225	1.6	0.29	90	5.2	3.7	0.5
14	Chitradurga	India	8.6	0.92	6.4	0.74	59	13	950	428	2.1	0.35	65	28.5	3.7	0.6
15	Mandore	India	8.6	2.09	5.4	0.58	60	29	761	426	2.0	0.70	52	16.6	3.3	0.6
16	Annur	India	8.0	1.14	6.5	0.84	51	15	1249	357	2.6	0.62	98	2.3	3.5	0.2
17	Allahbad	India	7.3	0.82	5.2	0.62	42	10	683	125	2.8	0.41	67	19.7	3.1	0.6
18	Khao Luang	Thailand	7.9	1.44	5.4	0.80	50	18	1191	418	1.1	0.12	95	2.5	5.0	0.3
19	Lamahi	Nepal	7.7	0.83	4.9	0.12	47	10	663	308	1.9	0.30	60	33.5	3.2	0.2
20	Geta	Nepal	8.0	1.10	5.4	0.65	51	15	896	148	2.1	0.48	75	23.4	3.7	0.4
21	Tibbi Laran	Pakistan	7.6	1.38	4.9	0.69	47	17	759	223	1.7	0.35	70	24.1	3.5	0.4
22	Multan	Pakistan	7.2	0.21	4.8	0.40	41	2	638	189	1.8	0.43	62	19.2	3.7	0.5
23	Sri Lanka	Sri Lanka	7.8	0.92	5.9	0.89	49	11	855	297	1.4	0.20	70	14.8	4.0	0.2
24	Bandia	Senegal	8.9	1.31	5.9	0.70	64	20	1384	581	2.1	0.63	85	11.0	3.6	0.3
Mean			8.0		5.6		52		1020		1.8		78		4.1	
Standard deviance			1.4		0.9		19		481		0.6		20		0.9	
$F_{provenance}$			2.3		3.0		2		3		10.7		3		9.6	
Significance			*		**		*		**		***		**		***	

* = Significant differences at 95% confident limit

** = Highly significant differences at 99% confident limit

*** = Highly significant differences at 99.9% confident limit

3.1.2 Height (H)

Height is usually considered an important variable in the evaluation of species and provenances. Height may be seen as an indicator of the adaptability of trees to the environmental conditions, tall provenances usually being better adapted to the site than short provenances.

The height of nine-year-old neem trees is shown in Figure 3. The average height of neem in the trial was 5.6 m., ranging from 4.5 m (provenance Tung Luang-Thailand) to 7.1 m. (provenance Ban Nong Rong-Thailand). The height growth of neem showed greater increase after 6 months and 1 year after planting, but after 2 years the height growth was only moderate. The mean height of provenance Ban Nong Rong-Thailand increased from the age of 3 year (4.99 m).

Compared to the study of 25 Thai provenances from natural distribution area, established at Surat Thani Province, the four year old provenance from Khao Luang Nakhon Sawan had the highest growth (5.73 m.) while neem from Klong Huai Traai Kamphaeng Phet, Rong Kwaang Phrae, Sawi Chumphon and provenance Phaisali had average growth rate in height at 5.3, 5.3, 5.2 and 5.0 m respectively. Neem from provenance Doi Tao had lowest height growth (3.3 m.) (Hongthong, 2007). See annex 1.

There were strong significant differences between provenances but no significant difference between blocks (Table 3).

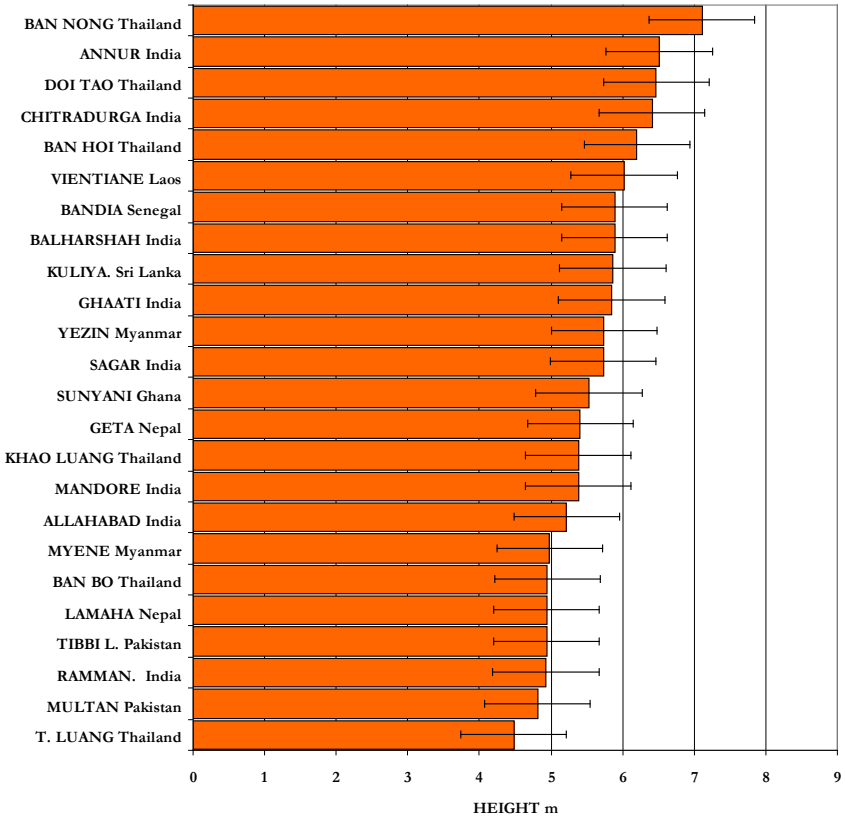

Figure 3. Height for the nine-year-old *Azadirachta indica* at Kanchanaburi Province

3.1.3 Basal area (BA)

The basal area is often used as a measure of the productivity of stands, as it is highly correlated with the biomass production. The basal area of the mean tree is calculated on living trees only and can be interpreted as the potential basal area production of the provenance provided that all trees survive.

As shown in the Figure 4, the mean basal area of nine-year-old neem was 52.4 cm^2, ranging from provenance Tung Luang (29.1 cm^2) to provenance Doi Tao, Thailand (82.9 cm^2). The second highest of basal area was provenance Ban Nong Rong (81.0 cm^2). The statistical significant difference was found only between provenance as shown in Table 3. The basal area is related to the diameter at breast height.

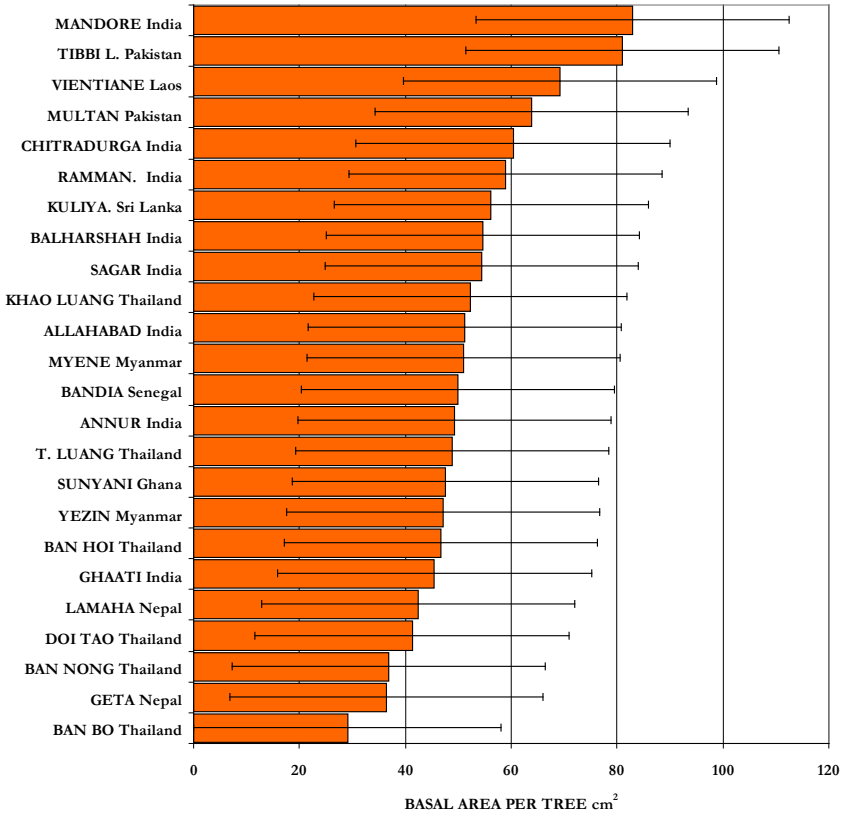

Figure 4. Basal area for the nine-year-old *Azadirachta indica* at the Kanchanaburi Province

Table 3. Analysis of Variance on growth performances of 9-year-old *Azadirachta indica* in the International Provenance Trial at Kanchanaburi Province, Thailand

	SV	d.f.	S.S.	M.S.	F	p Value
DBH	Block	3	1.7	0.564	0.36ns	0.780
(cm)	Seedlot	23	84.1	3.655	2.35*	0.003
	Residual	69	107.1	1.552		
	Total	95	192.9	2.030		
Height	Block	3	1.7	0.554	1.00ns	0.399
(m)	Seedlot	23	38.6	1.678	3.02**	<.001
	Residual	69	38.3	0.556		
	Total	95	78.6	0.827		
Basal Area	Block	3	280	93	0.33ns	0.804
(cm2)	Seedlot	23	14865	646	2.28*	0.004
	Residual	69	19516	283		
	Total	95	34661	365		
Total_BA	Block	3	576530	192177	1.29ns	0.284
(cm2)	Seedlot	23	11122231	483575	3.26***	<.001
	Residual	69	10249121	148538		
	Total	95	21947882	231030		
No of stems	Block	3	1.4	0.46	4.10**	0.010
(stem)	Seedlot	23	27.7	1.21	10.69***	<.001
	Residual	69	7.8	0.11		
	Total	95	36.9	0.39		
Stem form	Block	3	0.57	0.19	0.64ns	0.590
	Seedlot	23	64.6	2.81	9.59***	<.001
	Residual	69	20.2	0.29		
	Total	95	85.4	0.90		

ns = Insignificant
* = Significant differences at 95% confident limit
** = Highly significant differences at 99% confident limit
*** = Highly significant differences at 99.9% confident limit

3.1.4 Total basal area

In comparison to the basal area of the mean tree, the total basal area takes into account missing trees and can be a better measure of the actual production on the site.

The average total basal area for all provenances was 1020 cm^2. The survival rate of Ban Nong Rong was higher than Doi Tao (94% and 80%, respectively), and therefore Ban Nong Rong also had a higher average total basal area (1885 cm^2) than Doi Tao, which presented the biggest basal area per tree. On the other hand, provenance Tung Luang had the lowest average in both basal area (29.1 cm^2) and total basal area (493 cm^2) with a low 71% survival. The difference between highest and the lowest was approximately 74% (Figure 5). There was no difference between blocks, but the data indicated that within blocks there were strong differences between the provenances (Table 3). In this trial there is a large variation between plots. This variation is caused by various levels of survival, and this is probably related to an initial difficult start of the trial.

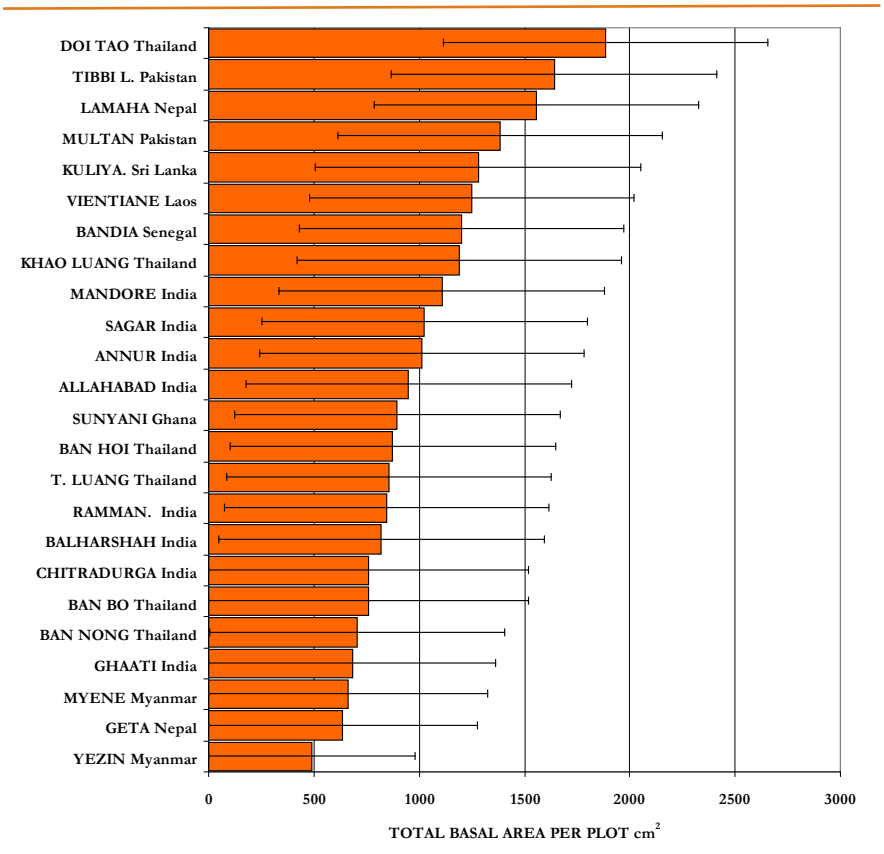

Figure 5. Total basal area for the nine-year-old *Azadirachta indica* at the Kanchanaburi Province.

3.1.5 Number of stems

The number of stems present the growth habit of the species. Trees with large numbers of stems are considered bushy, whereas trees with only one stem look more appropriate for timber production. The relative differences in stem numbers can easily be seen at the pictures in annex 2.

Figure 6 presents the results of number of stems in the study. The provenance Tung Luang only had trees with one single stem. The 2nd and the 3rd ranked provenances which have few stems were Vientiane-Laos (1.04 stems) and Ban Nong Rong (1.09 stems). Allahbad- India had about 2.8 stems for each tree. The provenances Annur and Sagar also had relatively many stems. The data shows that most provenances in this study had more than one stem / tree.

Table 3 also demonstrated that there were highly significant differences in the number of stems both between blocks and between provenances.

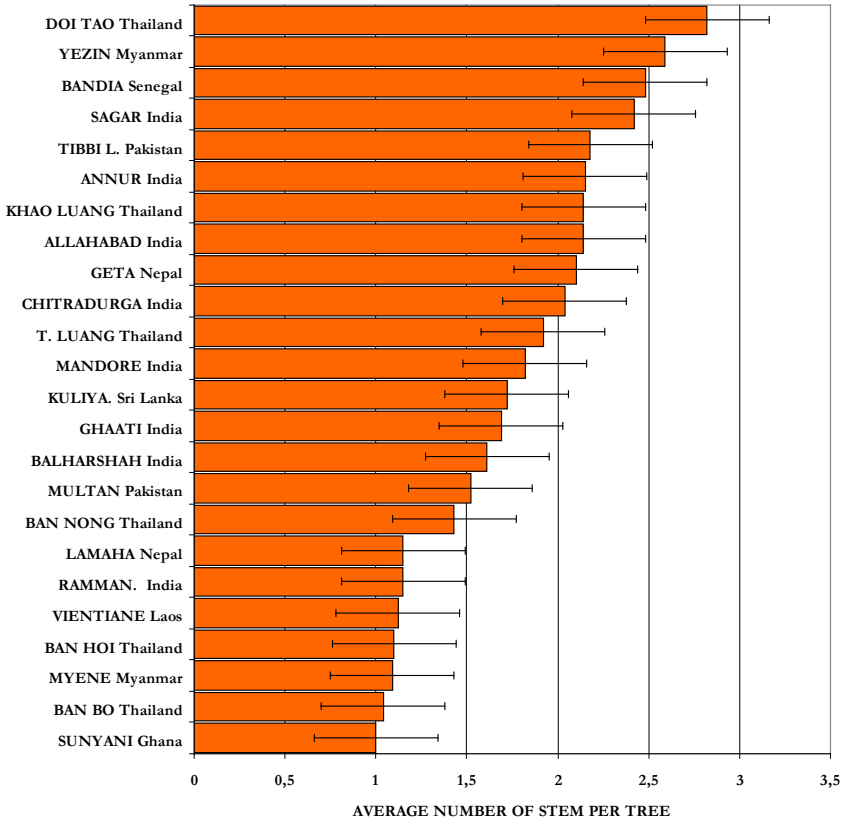

Figure 6. Number of stems for the nine-year-old *Azadirachta indica* at the Kanchanaburi Province.

3.1.6 Stem form

The mean value of stemform in this study was 4.1, ranking from 3.1 in provenance Allahabad- India to 6.2 for the provenance Ban Nong Hoi-Thailand as showed in Figure 7. The average trees in the trial had »wavy« stems but they were rarely crooked (severe bends). The estimation of stem form was difficult. The stemform was based on subjective individual judgment. It is important that the same person assess the value within each block and preferably also within the whole trial. However it is possible to make a reasonable ranking between the provenances. The high statistical significant differences was only found between provenances. In contrast, there were no significant differences between blocks (Table 3), which indicate a low influence of site conditions.

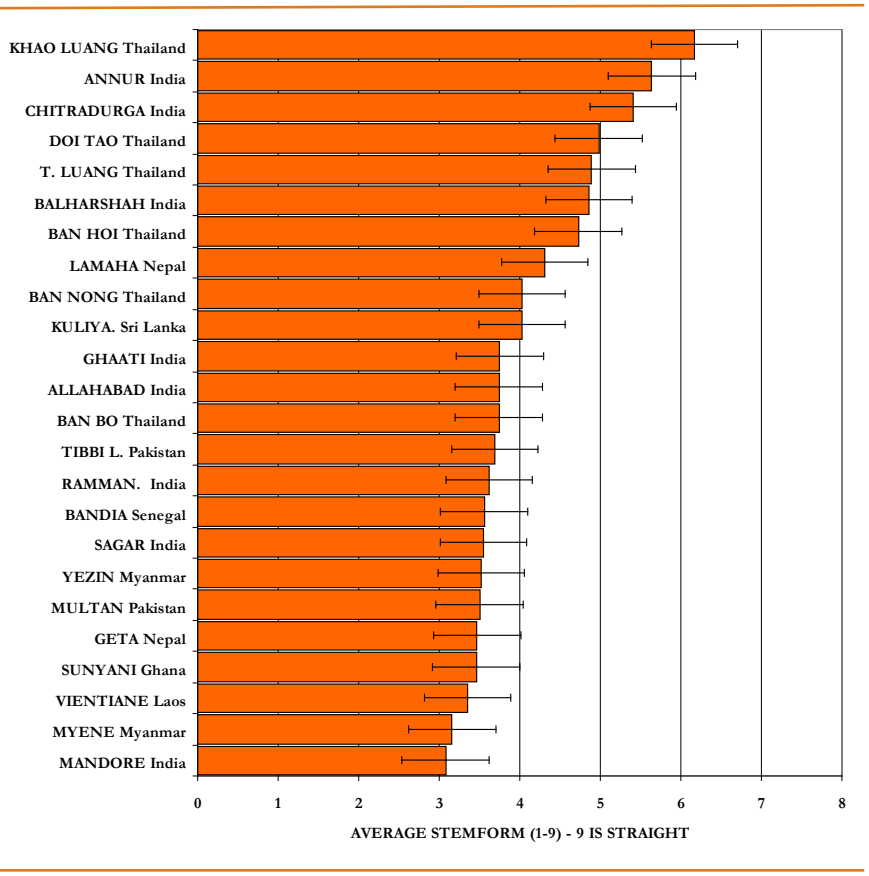

Figure 7. Stemform for the nine-year-old *Azadirachta indica* at Kanchanaburi Province

3.1.7 Variation on survival performance

Survival is regarded as a key variable when analyzing forest provenance trials, since it indicates the adaptation of the provenance to the environment at the trial site. It should be noted, that the survival rate reflects only the conditions experienced during the first few year's growth of the trial and not necessarily the climatic extremes and conditions that may be experienced during the life span of the tree population in the field.

As showed in Figure 8, the provenances which had a high survival rate were: Annur, India; Khao Luang-Thailand; Ban Nong Rong-Thailand; Ban Nong Hoi-Thailand; Myene-Myanmar; Yezin- Myanmar and Ghatii-India (98%, 96%,

94%, 93%, 91%, 90% and 90%, respectively). The lowest survival rate were found for the following provenances: Allahabad-India, Sagar-India, Chitradurga-India, Multan-Pakistan, Lamahi-Nepal and Mandore-India (67%, 65%, 65%, 62%, 60% and 52% respectively).

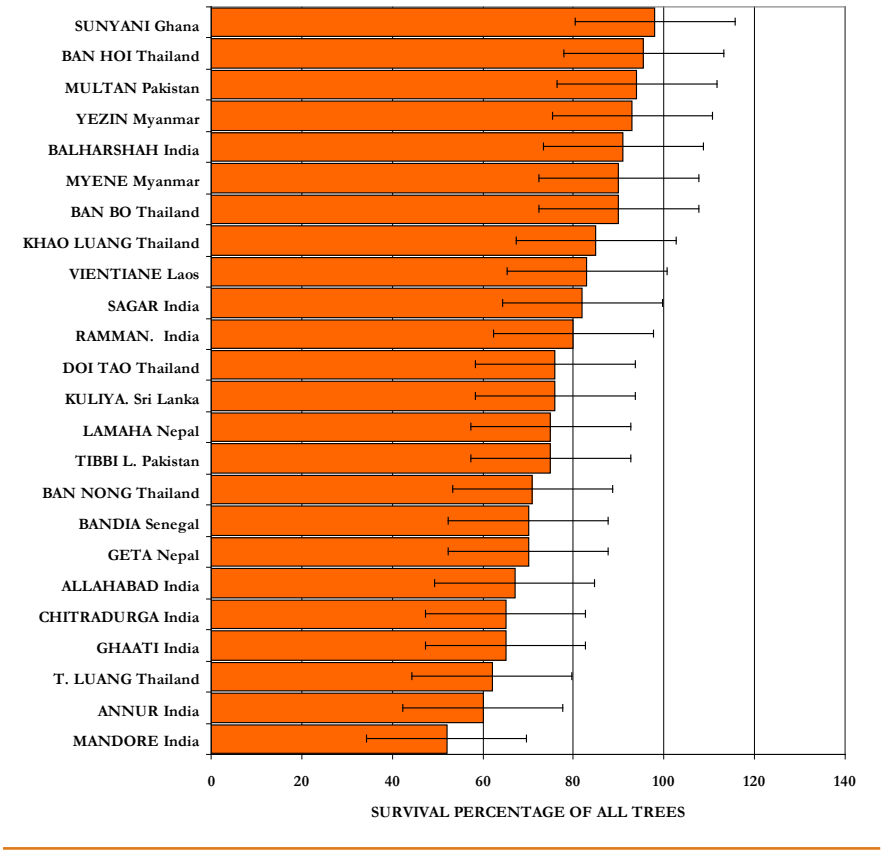

Figure 8. Survival rate for provenances of *Azadirachta indica* in the International Provenance Trial at Kanchanaburi Province

The Data from the Table 3 presents the survival rates for all provenances. statistical analysis showed that there was a high significant difference between provenances), while there were no significant difference between blocks as shown in Table 4.

Table 4. Analysis of Variance the percentage survival on nine-year-old *Azadirachta indica* characteristics at Kanchanaburi Province, Thailand

	SV	d.f.	S.S.	M.S.	F	p Value
Survival	Block	3	0.404	0.135	1.87ns	0.142
(%)	Seedlot	23	4.837	0.210	2.92***	<.0001
	Residual	69	4.963	0.072		
	Total	95	10.204	0.107		

ns = Insignificant
** = Highly significant differences at 99% confident limit
*** = Highly significant differences at 99.9% confident limit

3.4 Correlation of the growth performances

Correlation varies in the range -1 to 1 that presents the inter-relationship between two variables. A correlation of 1 implies that each variable is completely related to the other one, and that both increase and decrease together. A correlation of -1 again implies that they are related to each other but that one decreases while the other increases. A correlation of 0 shows, that there is no relationship between the variables. The correlation analysis of the growth performances is presented in Table 5.

Table 5. The results of correlations test on nine-year-old *Azadirachta indica* characteristics in the International Provenance Trial at Kanchanaburi, 2007

Growth performances	Diameter DBH	Height	Basal area	Number of stems	Stem form	Survival	Total basal area
DBH	1.000	0.93	0.99	-0.25	0.23	0.61	0.93
P-value		(0.000)	(0.000)	(0.490)	(0.202)	(0.252)	(0.000)
Height	0.93	1.000	0.95	-0.03	0.29	0.68	0.94
P-value	(0.000)		(0.000)	(0.937)	(0.141)	(0.021)	(0.000)
Basal Area	0.99	0.95	1.000	-0.30	0.29	0.60	0.94
P-value	(0.000)	(0.000)		(0.385)	(0.140)	(0.237)	(0.000)
No of stem	-0.25	-0.03	-0.30	1.000	-0.90	-0.16	-0.29
P-value	(0.490)	(0.937)	(0.385)	(0.000)	(0.000)	(0.734)	(0.339)
Stem form	0.23	0.29	0.29	-0.90	1.000	0.617	0.45
P-value	(0.202)	(0.141)	(0.140)	(0.000)		(0.070)	(0.034)
Survival	0.61	0.68	0.60	-0.159	0.61	1.000	0.84
P-value	(0.252)	(0.021)	(0.237)	(0.73)	(0.070)		(0.000)
Total Basal area	0.93	0.94	0.94	-0.289	0.45	0.84	1.000
P-value	(0.000)	(0.000)	(0.000)	(0.339)	(0.034)	(0.000)	

The results showed the highly significant correlation between diameter, height, basal area and total basal area. Total basal area is positive correlated with survival ($r=0.84$, $p<0.0001$). Higher survival rate of trees is related to a higher total basal area. On the other hand, number of stems showed negative correlation with most performances: DBH, height, basal area, total basal area, stem form and survival percentage. It could be assumed that a higher number of stems followed a lower diameter, height, basal area and total basal area, but such a relation has not been found (Figure 8). There was a strong negative correlation between the number of stems and stem form.

4. Comparison with the nine-year-old Azadirachta indica in the International Provenance Trial at Kamphaeng Phet Province, Thailand

Neem in the trial at Kamphaeng Phet province was established in the same year as neem at Kanchanaburi Province. 24 provenances from 9 regions (countries) were evaluated. Results showing the comparison from both sites are shown in Figures 9-11. The growth performance at Kamphaeng Phet was higher than at Kanchanaburi. Basal area was 56% higher. The Provenance Ban Nong Rong-Thailand and Ghaati-India showed approximately the same total basal area in the both sites. The number of stems per tree was less at the Kamphaeng Phet site which indicates a better performance than at the trial in the Kanchanaburi. It follows that Kamphaeng Phet is more suitable for good quality timber production. However, survival percentage and stem form of neem at Kanchanaburi were higher than at Kamphaeng Phet. The difference in survival was 25%, while the stem qualities showed relatively smaller differences in number of stems and stem form (18% and 1.9%, respectively).

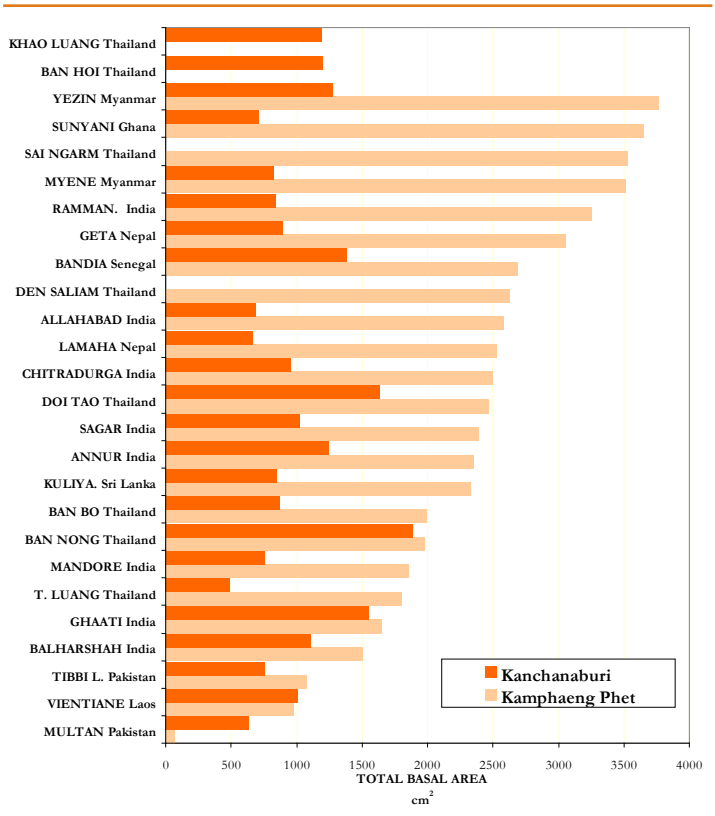

Figure 9. Total basal area for the nine-year-old *Azadirachta indica* in the trials at Kanchanaburi and Kamphaeng Phet sites

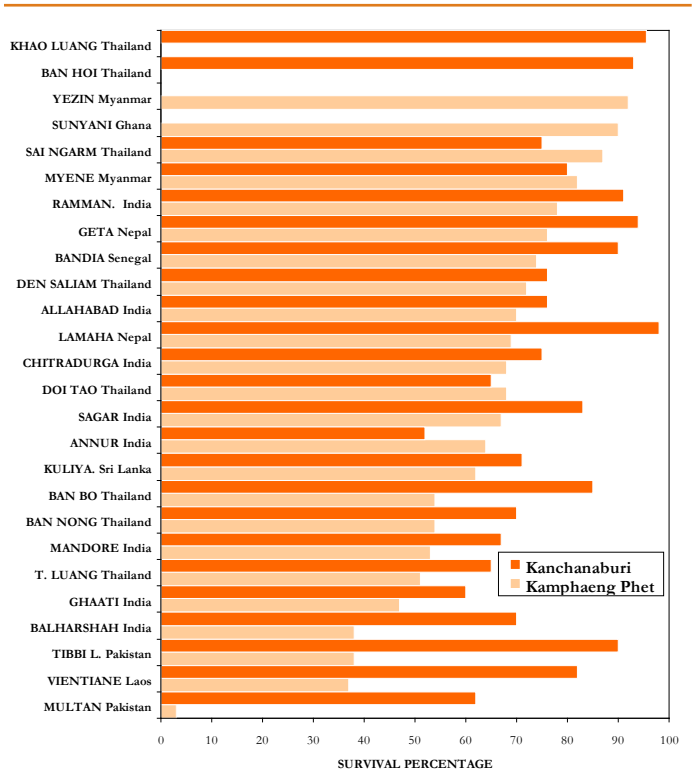

Figure 10. Survival of trees in the nine-year-old *Azadirachta indica* in the trials at Kanchanaburi and Kamphaeng Phet provinces

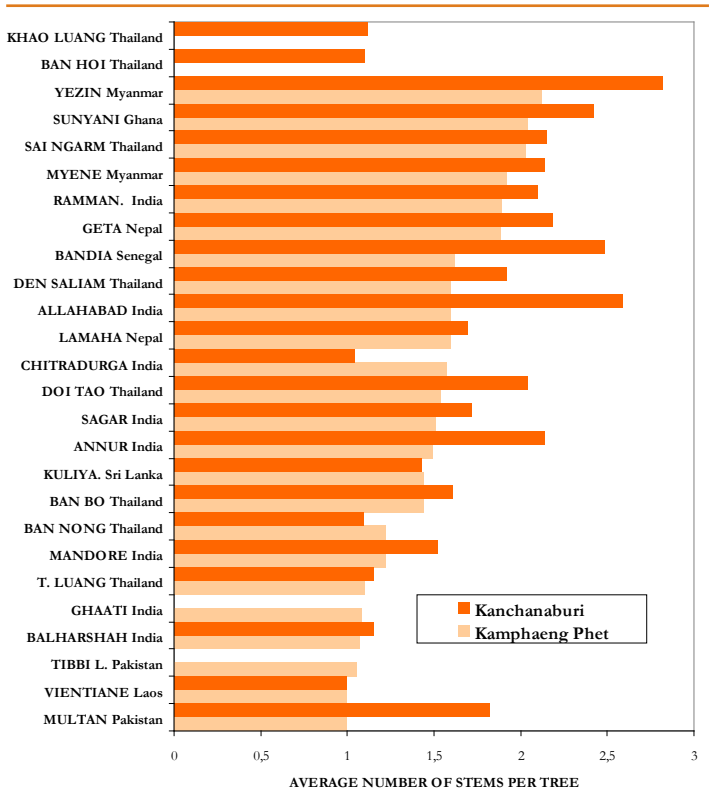

Figure 11. Number of stems in the nine-year-old *Azadirachta indica* in the trials at Kanchanaburi and Kamphaeng Phet provinces

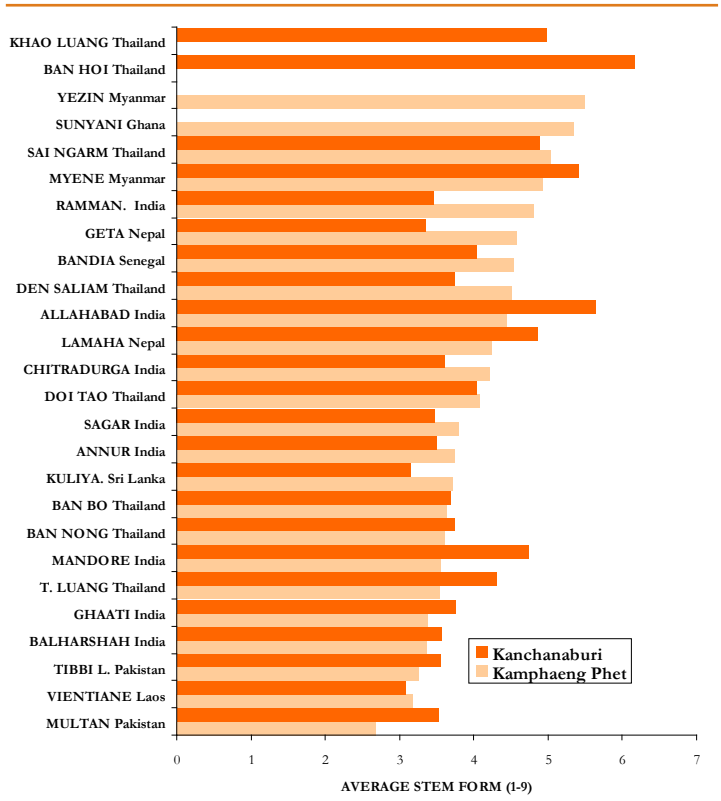

Figure 12. Stemform in the nine-year-old *Azadirachta indica* in the trials at Kanchanaburi and Kamphaeng Phet provinces

The survival percentages of most provenances in the Kanchanaburi trial were quite high. Provenances of neem from Thailand showed higher survival rate than those seed sources from other regions. Only three provenances at Kanchanaburi province presented a lower survival percentage than 40%.

For growth and survival it is striking that the ranking between provenances was different at the two sites (Fig. 9), i.e. it is difficult to point out one provenance that is superior in growth at both sites. The results indicate that it is necessary to make different recommendations of provenances for different regions of Thailand.

5. Discussion

The results from Kanchanaburi are dissimilar compared to the results from the Kamphaeng Phet trial. The survival rate of individual trees is generally higher, but the growth rate is significantly lower, and the same is stem quality (stem form and numbers). The yield capacity of the location is lower, which probably is a reflection of the much lower precipitation at Kanchanaburi.

The lower survival rate at Kanchanaburi might have been caused by fast growth and between tree competition. On the other hand – for many provenances, there are many poor stems left in Kanchanaburi and this might have a serious effect on the statistical evaluation of the provenances. Specific plots for certain provenances are really poor in survival (Vientiane, Tung Luang, Suniyani, Sagar (2plots), Chitradurga, Lamahi, Geta) and it affects the estimated mean values of growth. However removing the plots from the analysis would introduce a biasing effect as well. The reason why some plots are poor is uncertain, and it does not follow the block pattern in the trial. Refining the analysis with plot coordinates as co-variates does not improve the analysis, and this is probably because of lack of »degree of freedom« in the analysis of variance. One plot with the Tung Luang provenance – which is a slow growing provenance from southern Thailand in this trial - was partly destroyed by human intervention (cutting). The plot was placed close to the entrance of the site.

The local provenances of Ban Nong Rong is relatively good, Ban Nong Hoi intermediate. The two northern provenances are also different: Doi Tao is good and Khao Luang quite poor. These results are in contrast with the local studies including these provenances made by Hongthong (2007), where Khaou Luang is one of the best and Doi Tao an intermediate provenance.

The Thai provenances are quite variable in their growh and survival performance. The two mono stem provenances of Doi Tao and Ban Nong Rong is best with regard to biomass production in Kanchanaburi, but in Kamphang Phet, the two best provenances are multi stem provinces from Ghana and Yezin.

Provenances from Vientiane, Multan and Tibbi Laran are poor in Kamphaeng Phet, and they also generally perform poorly in the trials in Tanzania (Iversen et al. 2001). However in the Kanchanaburi trial they are not deviating very much from provenance mean. As an example is the provenance Multan with a survival rate of 62% in Kancahanaburi. In Kamphaeng Phet it was only 3%. The provenance trials clearly demonstrate that there is a strong interaction between site conditions and the origin of the provenances which are used in the trials.

6. Conclusion

The study of the International Neem Provenance trials of 9 years old trees at Kanchanaburi Province has the following conclusions:

1. The average DBH was 8.1 cm. The largest diameter was found for provenance Doi Tao-Thailand (10.2 cm.) and the lowest for Tung Luang-Thailand (6.0 cm). The diameter revealed significantly difference between provenances). There was not significant difference between blocks.

2. The average height was 5.6 m., ranging from 4.5 m (provenance Tung Luang-Thailand) to 7.1 m. (provenance Ban Nong Rong-Thailand). There was a high significant difference between provenances, but no significant difference between blocks (Table 3).

3. The mean basal area of nine-year-old neem was 52.4 cm^2, ranging from provenance Tung Luang (29.1 cm^2) to provenance Doi Tao-Thailand (82.9 cm^2). The difference between provenances was significant, but no significant block variation was found.

4. The average total basal area for all provenances was 1020 cm^2. Provenance Ban Nong Rong-Thailand had the highest average total basal area (1885 cm^2). On the contrary provenance Tung Luang-Thailand had the lowest total basal area (493 cm^2). There was no significant difference between blocks, and neither between.

5. The Tung Luang provenance of Thailand has only one stem on average. The Thai and Laotian provenances often had one stem. Most of the other provenances in this study had more than one stem for each tree (multi stem). There were highly significant differences in the number of stems both between the blocks and between provenances.

6. The mean value of stem form in this study was 4.1, ranking from 3.1 for the Indian provenance Allahabad to 6.2 for the Thai provenance Ban Nong Hoi. The trees in this study had wavy stems but no severe crooks. The statistical significant differences was only between provenances and not between blocks.

7. The provenances with highest survival rate were Annur (India); Khao Luang, Ban Nong Rong, Ban Nong Hoi (all Thailand); Myene, Yezin (both Myanmar) and Ghatii, India (98%, 96%, 94%, 93%, 91%, 90% and 90%, respectively). In contrast there were six provenances with a survival less than 70%: Allahbad; Sagar; Chitradurga; (India), Multan, (Pakistan), Lamahi (Nepal) and Mandore (India) (67%, 65% , 65%, 62%, 60% and 52%, respectively). The statistical analysis showed that there were highly significant differences between provenance, while there were no significant differences between the blocks.

8. The results showed high significant correlations between diameter, height, basal area and total basal area. Total basal area was also positive correlated with the survival percentage. The number of stems showed negative correlation with most of the traits. A strong negative correlation was found between the number of stems and stem form.

9. The comparison of results between both international neem trials in Thailand, showed that the total basal area at Kamphaeng Phet was higher than at Kanchanaburi. Moreover, the number of stems at the Kamphaeng Phet showed better performance than at Kanchanaburi. However, survival rate and stem form at Kanchanaburi was better than at the Kamphaeng Phet. The difference in survival rate was 25%, while the qualities of stem characteristics showed little differences in »stem number« and »stem form« (18% and 1.9%, respectively).

10. For practical recommendations, suitable provenances for planting in Kanchanaburi are provenance Doi Tao and Ban Nong Rong from Thailand and Bandia from Senegal.

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Annex 1: Result of biomass/tree production (kg.) in four provenance trials with Thai neem in Thailand

The provenances in Kamphang Phet and Kanchanaburi international neem trials in bold (Hongthong, 2007).

Provenance	Huay Mud Exp. Station Surat Thani	Prachuap Khiri Khan Exp. Station	Kamphaeng Phet Exp. Station	Donglan Seed Production Station Khon Kaen
1. Khao Luang Nakhon Sawan	**3.31***	**4.34**	**2.31**	**8.29***
2. Nong Hoi Kanchanaburi	**1.22**	**2.47**	**2.33**	**6.28**
3. Huai Traai Tai Phetchaburi	1.33	5.33	2.81	7.50
4. Satuk Burirum	1.13	3.60	1.67	6.10
5. Nang Rong Burirum	**2.01**	**5.25**	**2.32**	**6.83**
6. Kaeng Khoi Saraburi	1.93	3.17	2.24	7.32
7. BungTabPrang Nahon Ratchsima	1.86	2.79	2.11	7.57
8. Phanom Thuan Kanchanaburi	1.71	3.77	3.29***	5.02
9. Phaisali Nakhon Sawan	3.52**	4.50	2.44	6.53
10. Klong Huai Traai Kamphaeng Phet	2.66	3.32	2.03	6.91
11. Nong Khae Phichit	1.56	2.65	2.61	5.86
12. Khao Luang Uthai Thani	2.33	-	-	-
12/1 Ko sariem Chiang Mai	-	7.35**	2.14	7.25
13. Den Saliam Tak	**2.68**	**4.90**	**1.21**	**7.34**
14. Lom Sak Phetchabun	1.41	4.83	2.85	7.87
15. Klong Chang Phitsanulok	2.34	1.30	2.05	5.71
16. Laplae Uttaradit	1.60	1.58	2.11	7.31
17. Rong Kwang Phrae	3.20	1.26	2.62	8.37**
18. Thap Sakae Prachuap Khiri Khan	1.61	8.26***	3.11*	8.37**
19. Sawi Chumphon	3.59***	4.48	2.46	5.67
20. Na Klang Udon Thani	1.67	4.21	1.99	6.39
21. Dong Rai Udon Thani	1.41	7.25*	2.70	7.31
22. Ta Put Thra Chaiyaphum	0.98	4.08	2.91	6.20
23. Doi Tao Chiang Mai	**0.48**	**3.86**	**2.29**	**6.88**
24. Ko Kha Lampang	1.57	3.67	1.74	6.01
25. Mae Tha Lampang	2.40	2.61	3.21**	9.05***

* Significantly different at 95% confident limit
** Significantly different at 99% confident limit
*** Highly significant differences at 99.9% confident limit

Annex 2. Data Kanchanaburi - nine years old

PROVENANCE	SEEDLOT	No	PLOTX	PLOTY	BLOCK	DBH07 cm	NOSTEM	H07 m	STEMFORM 1-9	SURV %
Ban Bo (Thailand)	21/THA/Bo	1	1	6	4	8.19	1.1	5.58	5.1	84
Ban Bo (Thailand)	21/THA/Bo	1	2	3	8	6.74	1.07	4.40	5.07	76
Ban Bo (Thailand)	21/THA/Bo	1	3	3	11	8.62	1.37	5.06	-	52
Ban Bo (Thailand)	21/THA/Bo	1	4	3	14	7.45	1.04	4.74	4.4	88
Ban Nong Hoi (Thailand)	26/THA/NoH	2	1	1	4	6.71	1.04	5.09	5.08	96
Ban Nong Hoi (Thailand)	26/THA/NoH	2	2	1	8	10.22	1.15	7.07	8.57	84
Ban Nong Hoi (Thailand)	26/THA/NoH	2	3	5	12	8.69	1.17	6.60	5.52	100
Ban Nong Hoi (Thailand)	26/THA/NoH	2	4	3	15	6.46	1.05	6.02	5.5	92
Ban Nong Rong (Thailand)	20/THA/Non	3	1	5	3	11.37	1.08	7.27	5.96	100
Ban Nong Rong (Thailand)	20/THA/Non	3	2	5	5	12.12	1.14	8.64	6.14	84
Ban Nong Rong (Thailand)	20/THA/Non	3	3	4	10	8.49	1.04	5.59	4.95	100
Ban Nong Rong (Thailand)	20/THA/Non	3	4	6	15	8.04	1.08	6.93	5.52	92
Doi Tao (Thailand)	22/THA/Doi	4	1	3	4	8.61	1	6.10	5.7	88
Doi Tao (Thailand)	22/THA/Doi	4	2	5	8	10.90	1.25	7.12	5.4	72
Doi Tao (Thailand)	22/THA/Doi	4	3	1	11	10.58	1.2	7.03	6.15	84
Doi Tao (Thailand)	22/THA/Doi	4	4	1	14	10.85	1.13	5.62	4.4	76
Vientiane (Lao)	11/LAO/Vie	5	1	4	2	7.87	1.1	5.57	4.52	92
Vientiane (Lao)	11/LAO/Vie	5	2	2	6	7.91	1	4.71	5.2	28
Vientiane (Lao)	11/LAO/Vie	5	3	6	12	6.49	1	4.50	4.31	96
Vientiane (Lao)	11/LAOxVie	5	4	2	15	8.08	1.05	4.93	4.89	88
Tung luang (Thailand)	19/THA/Thu	6	1	6	1	4.49	1	3.34	4.06	92
Tung luang (Thailand)	19/THA/Thu	6	2	1	5	6.26	1	4.85	5.38	56
Tung luang (Thailand)	19/THA/Thu	6	3	6	8	6.49	1	4.44	4.76	80
Tung luang (Thailand)	19/THA/Thu	6	4	3	16	6.84	1	5.30	5.36	56
Orissa (India)	10/IND/Ram	7	1	4	1	8.71	1.75	6.11	4	80
Orissa (India)	10/IND/Ram	7	2	2	6	8.28	2	5.18	4.38	88
Orissa (India)	10/IND/Ram	7	3	3	10	9.35	1.7	5.43	4.82	76
Orissa (India)	10/IND/Ram	7	4	3	13	6.74	1.44	6.82	4.05	84
Yezin (myanmar)	12/MYA/Yez	8	1	5	4	9.65	2.2	7.46	3.6	100
Yezin (myanmar)	12/MYA/Yez	8	2	1	7	7.06	2.43	5.13	3.12	76

PROVENANCE	SEEDLOT	No	PLOTX	PLOTY	BLOCK	DBH07 cm	NOSTEM	H07 m	STEMFORM 1-9	SURV %
Yezin (myanmar)	12/MYA/Yez	8	3	4	12	6.65	2.62	5.20	3.7	96
Yezin (myanmar)	12/MYA/Yez	8	4	5	14	9.97	2.42	5.15	3.47	88
Sunyani (Ghata)	23/GHA/Sun	9	1	3	1	6.70	2.05	5.4	3.44	76
Sunyani (Ghata)	23/GHA/Sun	9	2	4	8	7.93	2.45	6.11	3.59	88
Sunyani (Ghata)	23/GHA/Sun	9	3	5	8	5.74	2.05	4.82	3.45	84
Sunyani (Ghata)	23/GHA/Sun	9	4	4	14	6.89	2.15	5.77	3.61	56
Myene (myanmar)	13xMYAxMye	10	1	6	2	7.33	1.78	5.26	3.82	92
Myene (myanmar)	13xMYA/Mye	10	2	6	8	6.29	2.14	4.60	3.27	100
Myene (myanmar)	13/MYA/Mye	10	3	5	10	6.06	2.1	4.61	3.5	92
Myene (myanmar)	13/MYA/Mye	10	4	5	13	7.44	2.57	5.46	3.42	80
Sagar (India)	08/IND/Sag	11	1	4	4	10.98	1.5	7.92	4.79	96
Sagar (India)	08/IND/Sag	11	2	2	8	7.72	1.16	5.38	3.83	84
Sagar (India)	08/IND/Sag	11	3	1	10	6.65	1.16	5.15	4	28
Sagar (India)	08/IND/Sag	11	4	4	16	7.36	2.27	5.64	3.5	52
Balharshah (India)	09/IND/Bal	12	1	5	1	8.41	2.22	5.82	3.68	88
Balharshah (India)	09/IND/Bal	12	2	3	7	7.91	3.12	5.63	3.25	76
Balharshah (India)	09/IND/Bal	12	3	4	11	7.75	2.46	5.34	3.66	80
Balharshah (India)	09/IND/Bal	12	4	2	14	7.61	2.11	6.14	3.88	88
Ghatii (India)	07/IND/Gha	13	1	6	3	8.94	1.6	6.28	3	92
Ghatii (India)	07/IND/Gha	13	2	1	8	8.92	1.23	5.90	4.07	84
Ghatii (India)	07/IND/Gha	13	3	6	10	9.35	1.93	6.07	3.63	96
Ghatii (India)	07/IND/Gha	13	4	4	13	10.27	1.66	5.14	4.04	88
Molakalmur (India)	04/IND/Chi	14	1	3	2	8.39	1.9	5.73	3.35	80
Molakalmur (India)	04/IND/Chi	14	2	3	6	8.39	2.33	5.88	3.16	24
Molakalmur (India)	04/IND/Chi	14	3	2	11	9.94	2.53	6.72	4.3	68
Molakalmur (India)	04/IND/Chi	14	4	2	16	7.78	1.8	7.30	4.19	88
Mandore (India)	03/IND/Man	15	1	1	2	6.81	1.4	4.51	3.41	72
Mandore (India)	03/IND/Man	15	2	4	7	7.01	2.27	5.61	2.7	48
Mandore (India)	03/IND/Man	15	3	3	12	9.25	1.57	5.62	4.14	32

PROVENANCE	SEEDLOT	No	PLOTX	PLOTY	BLOCK	DBH07 cm	NOSTEM	H07 m	STEMFORM 1-9	SURV %
Mandore (India)	03/IND/Man	15	4	6	13	11.24	2.92	5.77	3.15	56
Annur (India)	06/IND/Ann	16	1	5	2	9.72	1.9	7.30	3.79	96
Annur (India)	06/IND/Ann	16	2	3	5	7.41	2.28	5.83	3.54	100
Annur (India)	06/IND/Ann	16	3	5	11	7.58	3.3	5.73	3.39	100
Annur (India)	06/IND/Ann	16	4	5	16	7.33	2.86	7.17	3.47	96
Allahbad (India)	05/IND/All	17	1	2	3	6.73	2.4	4.60	2.26	68
Allahbad (India)	05/IND/All	17	2	4	8	7.07	3.37	6.07	3.26	64
Allahbad (India)	05/IND/All	17	3	3	9	6.94	2.82	5.03	3.21	92
Allahbad (India)	05/IND/All	17	4	1	13	8.53	2.7	5.19	3.60	44
Khao Luang (Thailang)	27/THA/Kha	18	1	4	3	9.51	1.25	6.35	5.37	96
Khao Luang (Thailang)	27/THA/Kha	18	2	6	7	6.01	1.17	4.43	4.52	96
Khao Luang (Thailang)	27/THA/Kha	18	3	1	12	8.17	1.04	5.17	5.04	92
Khao Luang (Thailang)	27/THA/Kha	18	4	5	15	7.81	1	5.55	5.00	98
Lamahi (Nepal)	14/NEP/Lam	19	1	3	3	8.71	1.6	5.04	2.91	52
Lamahi (Nepal)	14/NEP/Lam	19	2	5	7	7.22	2.29	4.97	3.05	84
Lamahi (Nepal)	14/NEP/Lam	19	3	2	9	6.87	1.77	4.98	3.36	88
Lamahi (Nepal)	14/NEP/Lam	19	4	6	16	8.08	2	4.76	3.33	16
Gota (Nepal)	15/NEP/Get	20	1	1	1	7.82	1.72	4.59	3.59	88
Gota (Nepal)	15/NEP/Get	20	2	6	5	7.51	2.8	5.39	3.29	88
Gota (Nepal)	15/NEP/Get	20	3	2	12	9.6	2.14	5.48	3.85	40
Gota (Nepal)	15/NEP/Get	20	4	1	16	7.1	1.88	6.19	4.22	84
Tibbilaran (pakistan)	16/PAK/Tib	21	1	1	3	6.22	1.3	3.95	2.83	72
Tibbilaran (pakistan)	16/PAK/Tib	21	2	5	8	6.82	2.09	5.12	3.44	92
Tibbilaran (pakistan)	16/PAK/Tib	21	3	2	10	8.13	1.5	5.14	3.72	80
Tibbilaran (pakistan)	16/PAK/Tib	21	4	2	13	9.32	1.85	5.56	3.85	36
Mutan (pakistan)	17/PAK/Mul	22	1	2	4	7.02	1.52	4.59	3.47	84
Mutan (pakistan)	17/PAK/Mul	22	2	6	8	7.12	1.6	4.53	3.50	44

PROVENANCE	SEEDLOT	No	PLOTX	PLOTY	BLOCK	DBH07 cm	NOSTEM	H07 m	STEMFORM 1-9	SURV %
Mutan (pakistan)	17/PAK/Mul	22	3	4	8	7.45	2.46	5.40	3.50	72
Mutan (pakistan)	17/PAK/Mul	22	4	6	14	7.40	1.70	4.73	4.50	48
Sri Lanka	18/SRL/Kul	23	1	2	2	8.39	1.20	5.15	4	52
Sri Lanka	18/SRL/Kul	23	2	2	7	7.14	1.33	5.35	3.81	64
Sri Lanka	18/SRL/Kul	23	3	6	11	8.86	1.62	5.81	4.25	84
Sri Lanka	18/SRL/Kul	23	4	4	15	7.00	1.58	7.12	4.05	80
Bandia (Senegal)	24/SEN/Ban	24	1	2	1	8.02	2.10	5.64	3.35	72
Bandia (Senegal)	24/SEN/Ban	24	2	4	5	8.26	2.95	6.80	3.38	92
Bandia (Senegal)	24/SEN/Ban	24	3	1	9	8.61	1.47	5.14	3.55	80
Bandia (Senegal)	24/SEN/Ban	24	4	1	15	10.88	1.86	5.99	3.95	96

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